



U.S. Army Research, Development and Engineering Command



TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

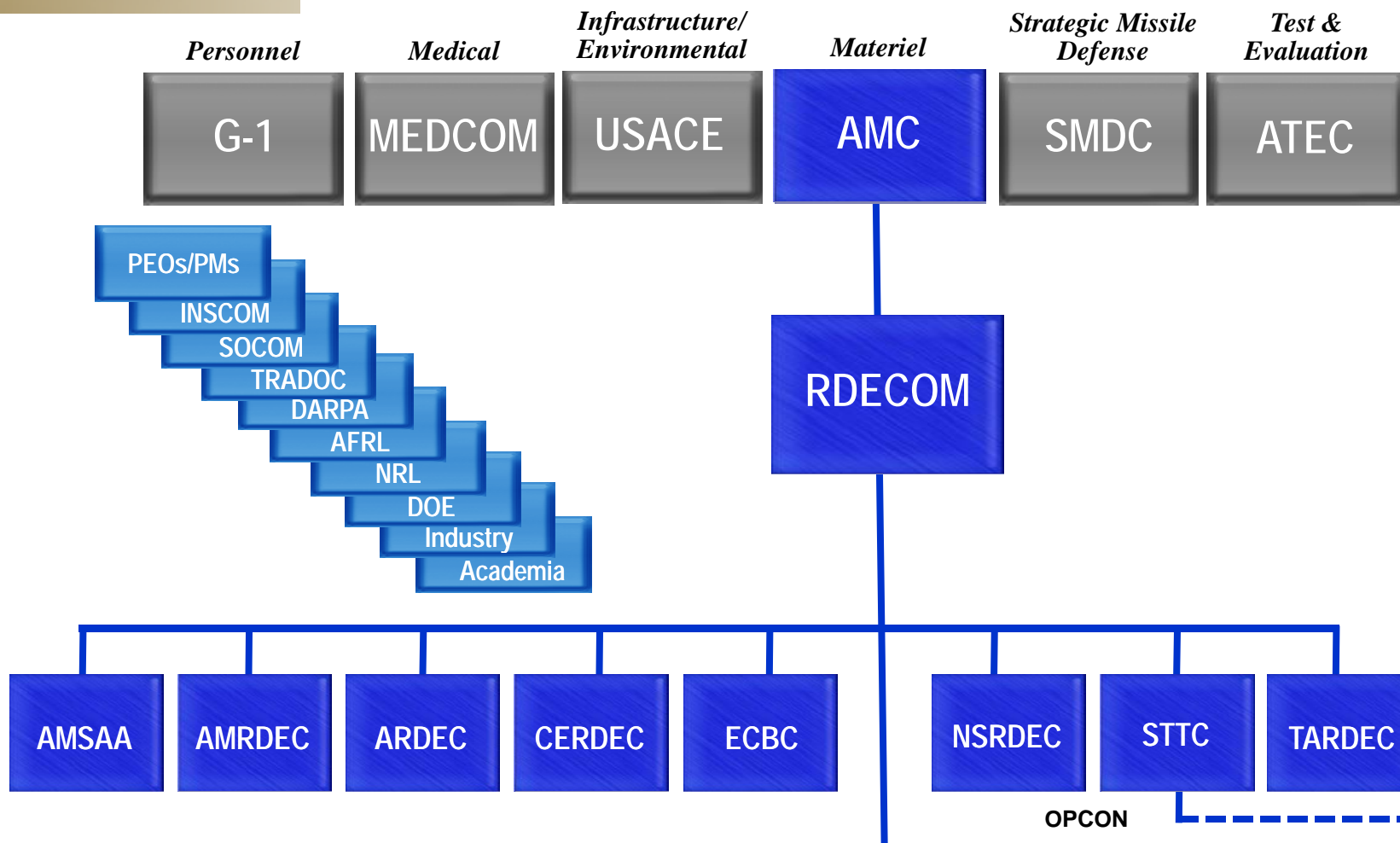
Human Performance Research at the
Army Research Laboratory
September 22, 2010

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14. ABSTRACT The Army Research Laboratory (ARL)'s mission is to provide innovative science, technology, and analysis to enable full-spectrum operations. The Human Research and Engineering Directorate (HRED) of the ARL has a dual mission: to conduct scientific research and technology development focused on optimizing Soldier performance to increase system mission effectiveness, and provide human system integration (HSI) leadership to ensure that Soldier performance requirements are adequately considered in technology development and system design. HRED's scientific research explores areas such as neuroscience, cognitive science, visual & auditory processing to identify ways to extend the Soldier's physical, perceptual, cognitive, and psychological performance across all operations. As a leader in HSI, HRED develops analysis methods, models, and simulations to conduct early assessment of design concept and implementation of key human system design principles. This brief will provide an overview of HRED's research focus in these mission areas.					
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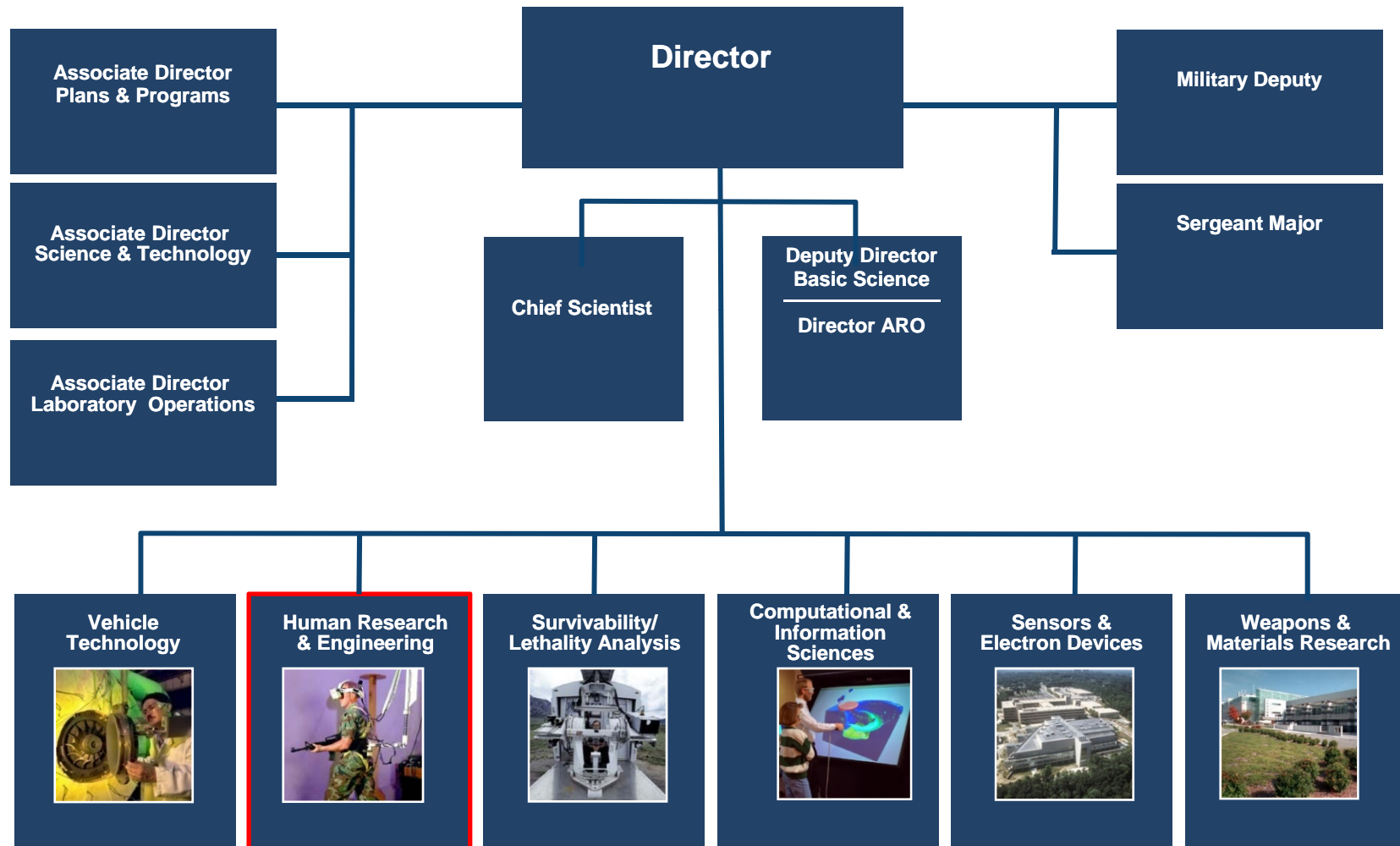
Army RDT&E Performing Organizations



**ARL provides underpinning Science, Technology,
and Analysis to the Army**



U.S. Army Research Laboratory





ARL Major Laboratory Programs



Protection

- Materials and Manufacturing Science for Protection
- Vehicle Protection
- Individual Warfighter Protection

Lethality

- Energetic Materials & Propulsion
- Projectiles, Warheads, & Scalable Effects
- Affordable Precision Munitions
- Advanced Weapons Concepts
- Materials and Manufacturing Science for Lethality

Human Dimension

- Soldier Performance
- Neuroscience/Neuroergonomics
- Social/Cognitive Network Science
- Human Robotic Interaction
- Human Systems Integration

Training Technology

- Artificial Intelligence
- Training Application Environments
- Immersive Learning
- Virtual Interfaces & Synthetic Environments
- Advanced Distributed Simulation



Extramural Basic Research

- Chemistry
- Physics
- Life Sciences
- Nanoscience
- Environmental Sciences
- Materials Sciences
- Mechanical Sciences
- Mathematics
- Computing and Information Science
- Electronics

Network

- Battlespace Information Processing
- Tactical Communications & Networks
- Battlefield Weather for C2 & ISR
- Advanced Computing and Computational Sciences

Sensing

- Advanced Electro-Optical Technologies
- Advanced RF Technologies
- Autonomous Sensing
- Flexible Displays
- Electronic Materials/Devices
- Micro Autonomous Technologies

Power and Energy

- Directed Energy
- Hybrid Electric Vehicle, Platform, & Pulse Power
- Micro, Soldier, and Portable Power

Mobility

- Near Autonomous Unmanned Systems
- Vehicle Propulsion
- Platform Mechanics

Survivability/Lethality Analysis

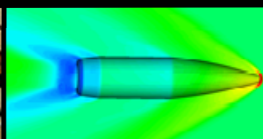
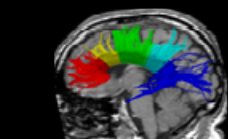
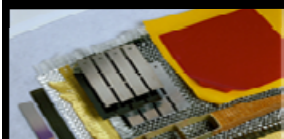
- Methodologies
- Future Combat Systems
- Combat Systems
- Air/Missile Defense
- C4ISR

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Strategic Research Initiatives



Materials in Extreme Environments

Inverse Materials Design

Nanoscience

Disruptive Energetics

Hierarchy: Translation between scales

Battlefield Neuroscience

Neuro-Cognitive Measurement

Cognitive/Information – Decision Making

Neurally Inspired Systems

Brain Structure-Function Coupling

Network Science

Cognitive/Information – Decision Making

System of System Analysis

Hierarchical Computing

Commodity Computing

Non-linear HPC

Multiscale Chemistry, Physics, & Mechanics M&S

Heterogeneous Electronics

Heterogeneous Devices

Graphene Nanoelectronics

Biologically Enabled

Extreme Energy Science

Nano to Micro Generators & Convertors

Energy Harvesting & Scavenging

Novel Energy Storage

Biologically Enabled

Autonomous Systems Technology

Autonomous Tactical Navigation

Cognitive Robotics

Scalable Autonomy

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ARL Partnerships UARCs, CTAs, ITA, CoEs



Centers Of Excellence

High Performance Computing

- Stanford University
- New Mexico State University
- Morgan State University
- University of Texas, El Paso
- High Performance Tech, Inc
- NASA - Ames

Flexible Displays

- Arizona State University

Materials

- University of Delaware
- Johns Hopkins University
- Rutgers University
- Drexel University
- Virginia Tech

University Affiliated Research Centers



Biotechnology

Biologically-derived:

- Sensors
- Electronics
- Information Processing



Soldier Survivability

- Protection
- Performance Enhancement
- Injury Intervention and Cure



Electromechanics & Hypervelocity Physics

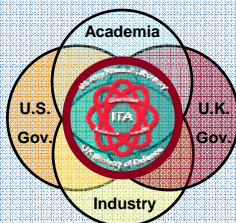
- EM Launch
- Pulsed-power
- Electric Armaments



Immersive Environments

- Full Sensory Immersion
- 3-D Mobility
- Compelling Interactive Stories

International Technology Alliance



Collaborative Technology Alliances

Robotics



Cognition and Neuroergonomics



Network Science



Micro Autonomous Systems & Technology





ARL HRED's Mission



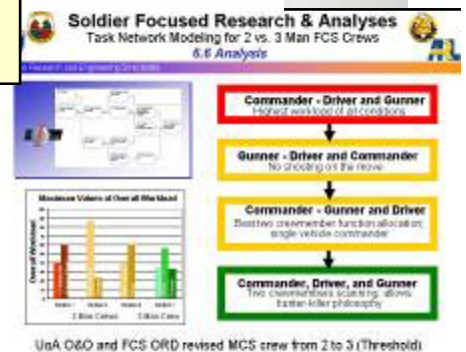
Laboratory & Field Experimentation



Assessment & Evaluation

Provide the Army and ARL with human factors leadership to ensure that Soldier performance requirements are adequately considered in technology development and system design.

Modeling & Simulation



MANPRINT Support

MANPRINT (Manpower & Personnel Integration)

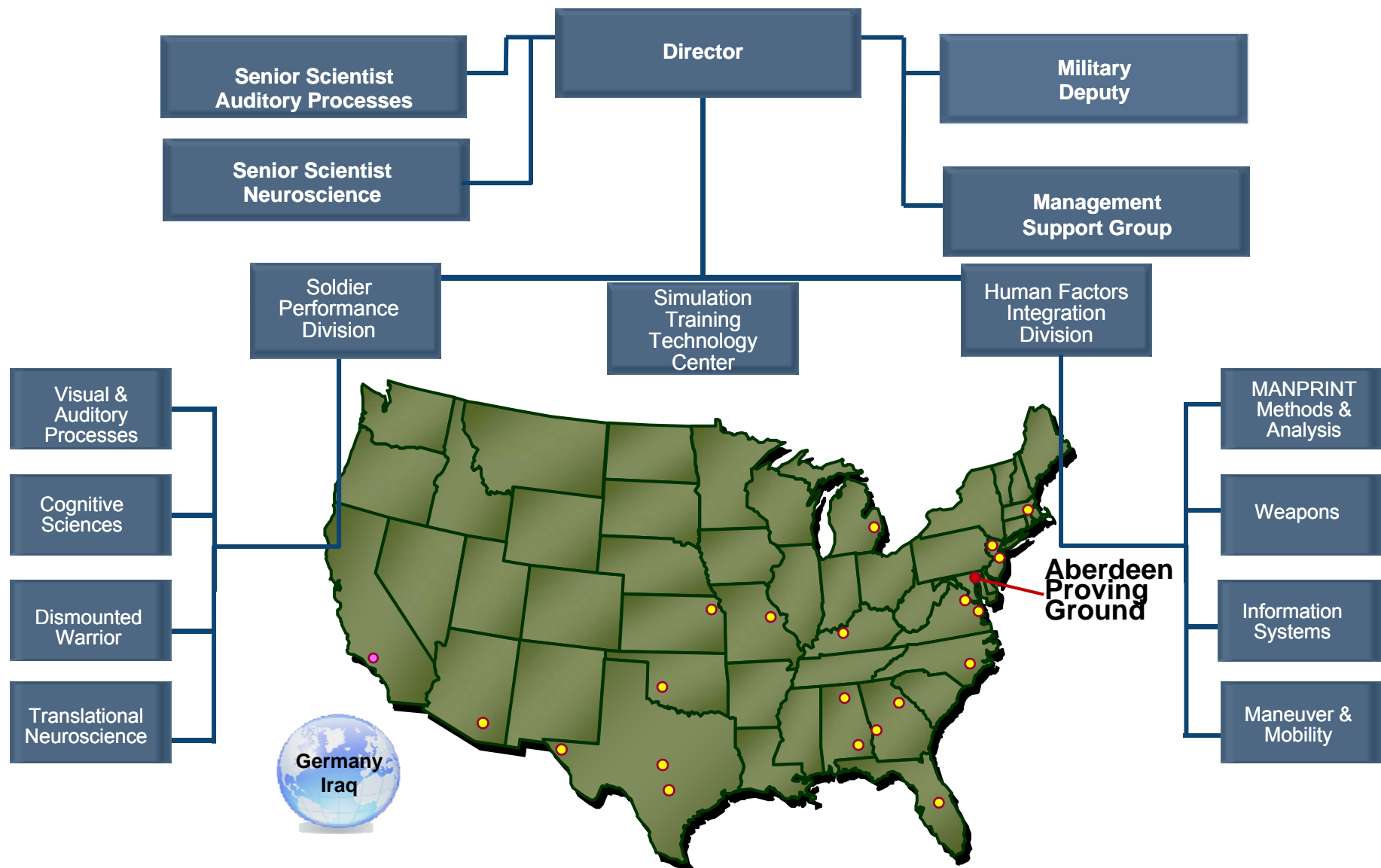
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Human Research and Engineering Directorate





Terminology



Human Systems Integration (HSI) is a multidisciplinary field of study that emphasizes human considerations as the top priority in systems design and acquisition to reduce life cycle costs and optimize system performance.

Manpower Personnel Integration (MANPRINT) is the US Army's instantiation and implementation of HSI. As in HSI, the goal is to optimize total system performance, reduce life cycle costs, and minimize risk of Soldier loss or injury by ensuring a systematic consideration of the impact of materiel design on Soldiers throughout the system development process.



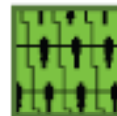
MANPRINT



MANPRINT Manpower & Personnel Integration



Seven MANPRINT Domains



Manpower

The number of military and civilian personnel required and available to operate, maintain, sustain, and provide training for systems in accordance with Title 10, U.S. Code, Armed Forces, Ch. 144, Section 2434.



Personnel Capabilities

The cognitive and physical capabilities required to be able to train for, operate, maintain, and sustain materiel and information systems.



Training

The instruction or education and on-the-job or unit training required to provide personnel and units with their essential job skills, knowledge, values and attitudes.



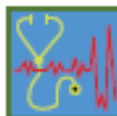
Human Factors Engineering

The integration of human characteristics into system definition, design, development, and evaluation to optimize human-machine performance under operational conditions.



System Safety

The design features and operating characteristics of a system that minimize human or machine errors or failures that cause injurious accidents.



Health Hazards

The design features and operating characteristics of a system that create significant risks of bodily injury or death; prominent sources of health hazards include loud noise, chemical and biological substances, extreme temperatures, and radiation energy.



Soldier Survivability

The characteristics of a system that can reduce fratricide, detectability, and probability of being attacked, and can minimize system damage, soldier injury, and cognitive and physical fatigue.

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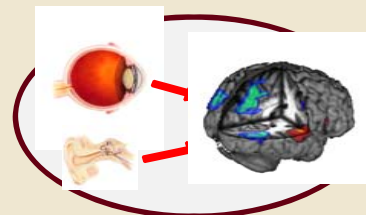


ARL HRED's Major Research Programs



- **Soldier Performance**
- **Neuroscience/Neuroergonomics**
- **Social/Cognitive Network Science**
- **Human Robot Interaction**
- **Human Systems Integration**

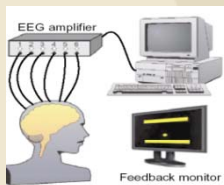
Multitasking In
Complex
Environments



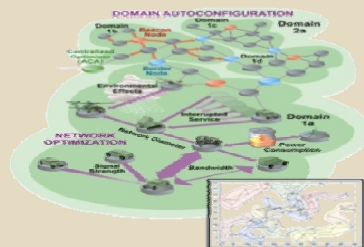
Displays for Effective
Multisensory
Integration



Neurally-Based Adaptive Systems



Basic Science



Tactical Human Integration with
Networked Knowledge



Individual, Cognitive, & Social Networks



C4ISR MANPRINT
Assessments



Ergonomic
Encumbered Human
Figure Models



Alternatives for Display
and Control of Robots



Evolving Technologies



Improving Safe And Accurate
Interpretation Of The AN/PSS-14
Auditory Display



Human-Figure
Workspace Modeling
for MRAP

**Current Ops /
Transitions**

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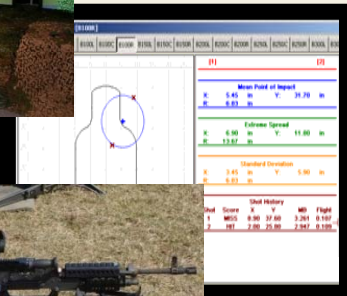
Soldier Performance Research



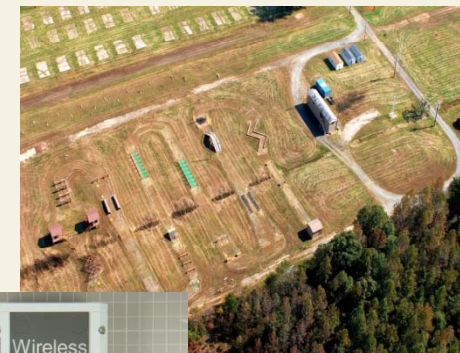
Optimize sensory, perceptual, and physical demands on the Soldier-system to improve survivability, sustainment, efficiency, and effectiveness



ergonomics



biodynamics

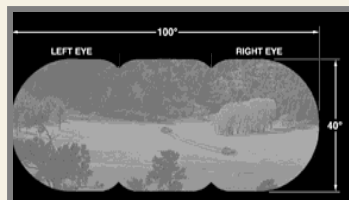
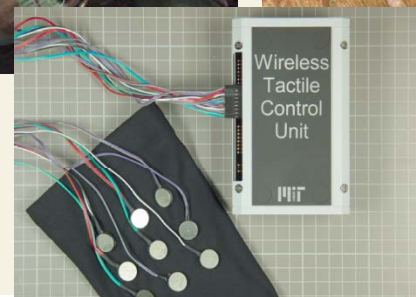


tactile

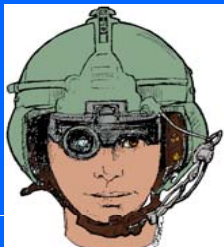


speech

auditory



visual



I²
0.6-1.0 μ

SW-IR
0.9-1.7 μ

LW-IR
8-12.0 μ

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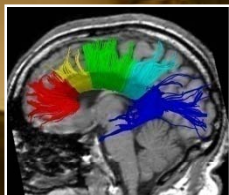
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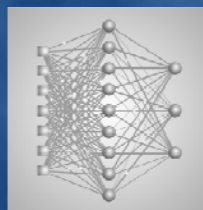
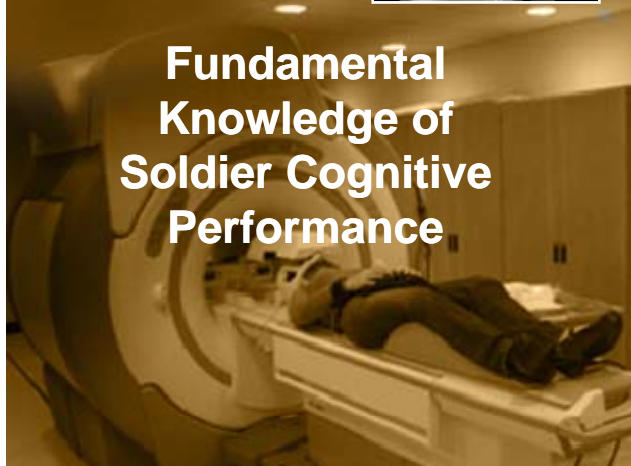
Strategic Research Initiative: Neuroscience



Emerging Imaging Technologies



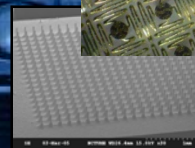
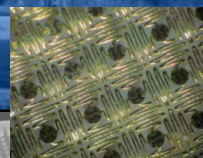
Fundamental Knowledge of Soldier Cognitive Performance



Advanced Cognitive Classification Algorithms

Advanced Operational Neuro-Cognitive Measurement

MEMS & Nano-Scale Neural Sensors



Neurally-Based Adaptive Systems

Neuroergonomic System Designs



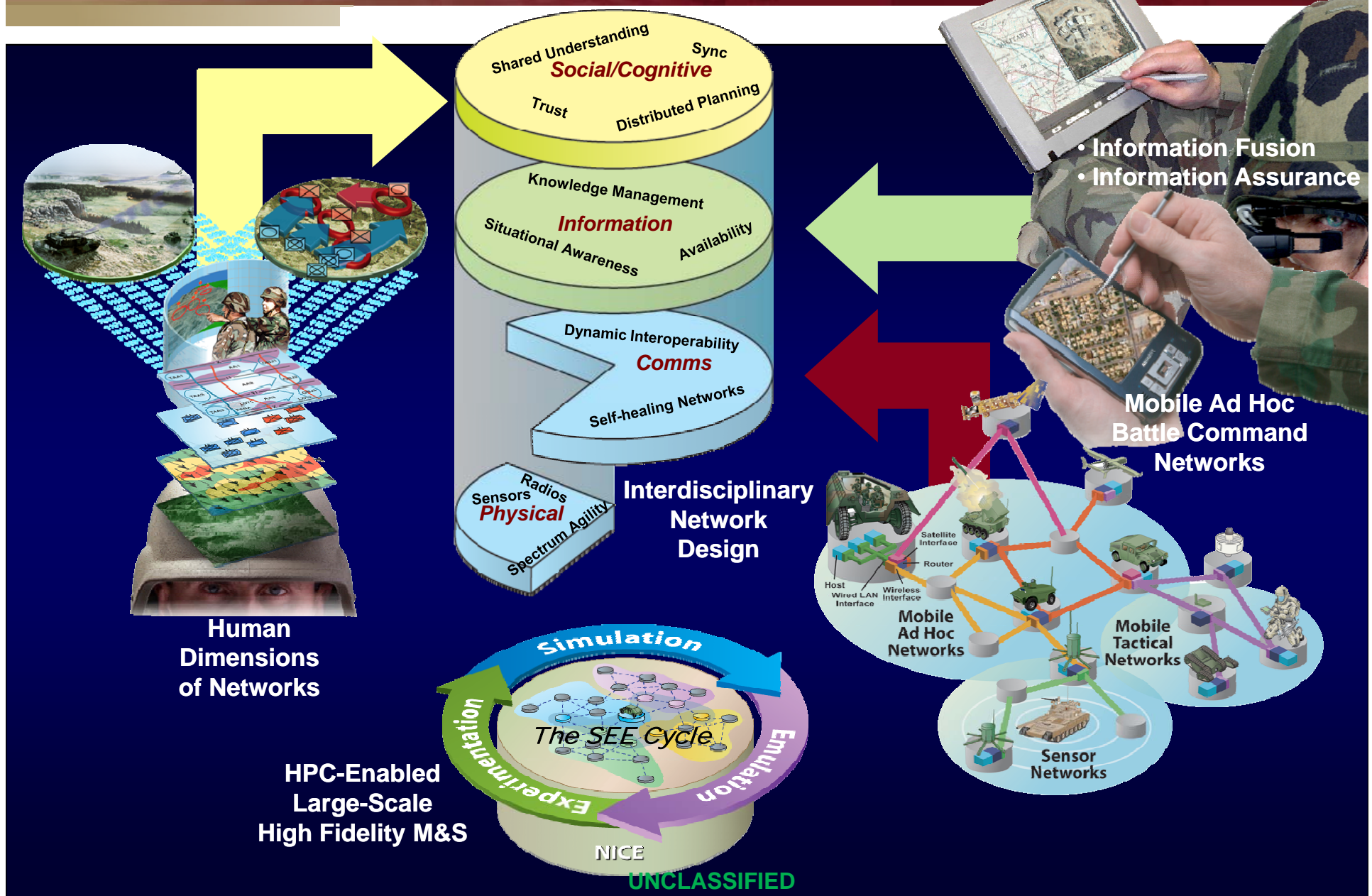
Real-time Soldier Monitoring

Understanding Soldier Brain Function to Improve System Performance



US ARMY
RDECOM

Strategic Research Initiative: Network Science







Strategic Research Initiative: Autonomous Systems





Large-Scale Robotics
Technologies supporting
Maneuver Forces



Autonomous
Mobility and
Dexterous
Manipulation
for
Man-Portable
Systems



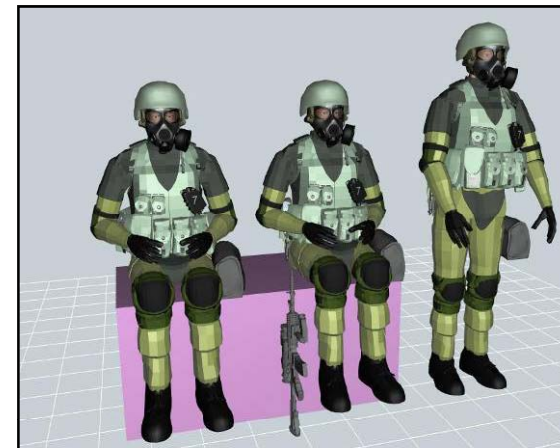
Micro-Autonomous
System Technologies
breeding a new
class of Soldier assets



Providing the Soldier with superior situational awareness

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- Tools for early, cost effective insertion of MANPRINT criteria requirements to optimize Soldier-system performance and cost at the systems of systems level
- Quantitative Warfighter requirements analysis to avoid overload that leads to increased injury, fratricide, and decreased mission performance



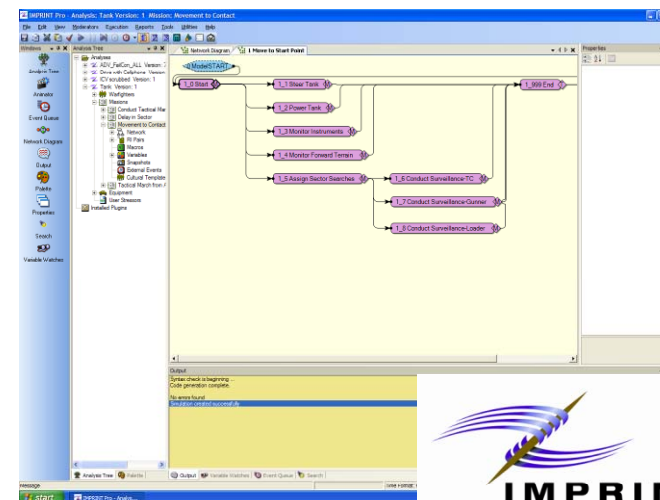
Human Figure Models

CHALLENGES

- Tools:
 - Evolving analysis demands
 - Barriers to usage
 - Human performance empirical data voids
- Assessment & Support
 - Large volume of acquisition programs and data voids
 - Tailored acquisition programs shorten timeline

ONGOING EFFORTS

- Tools:
 - Human performance moderator algorithms – environment and training
 - Tradeoff tool for Multimodal Interface Design
- Assessment & Support
 - Human performance analysis metrics for complex systems
 - Quantify MANPRINT risks and tradeoffs
 - Link HSI and Systems Engineering analyses
 - Increase percentage of acquisition programs assessed *TE*



Human Performance Models



Simulation & Training Technology Center



Special Program: ICT



- SGT S
- BiLAT
- UrbanS
- MCIT

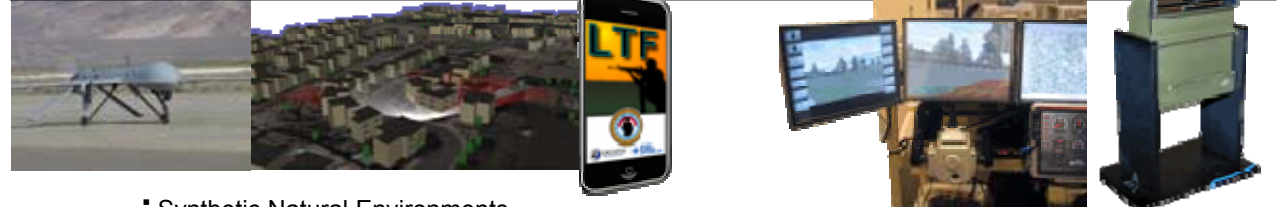
Soldier Simulation Environments Division



- HapMed
- TC3
- MR MOUT
- Immersive Environments

- Combat Medic Card Game
- Severe Trauma Simulation

Ground Simulation Environments Division



- Synthetic Natural Environments
- VIRAT

- Embedded Training

Special Program: MATREX



Blended Simulation Research Division



- Virtual Worlds
- Tactical Digital Holograms
- Virtual Interfaces
- Mobile Devices



- Second Life
- Robotics

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ARL HRED Facilities



- Dismounted Infantryman Survivability & Lethality Testbed (DISALT)
- Shooter Performance Facility (M Range)
- Mobility & Portability Course (KD Range)
- Tactical Environment Simulation Facility (TESF)
- Cognitive Assessment, Simulation, & Engineering Laboratory (CASEL)
- Environment for Auditory Research (EAR)
- Neural Engineering & Research In Vehicle Environments (NERVE)



DISALT



M-Range



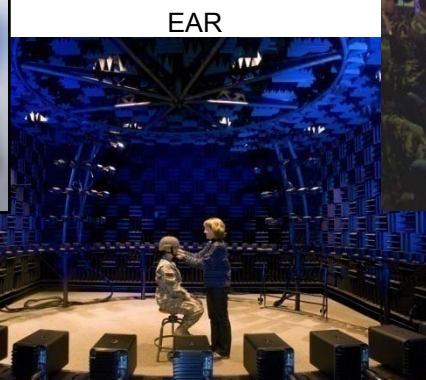
KD-Range



TSEF



NERVE



EAR



CASEL

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Human Performance Modeling

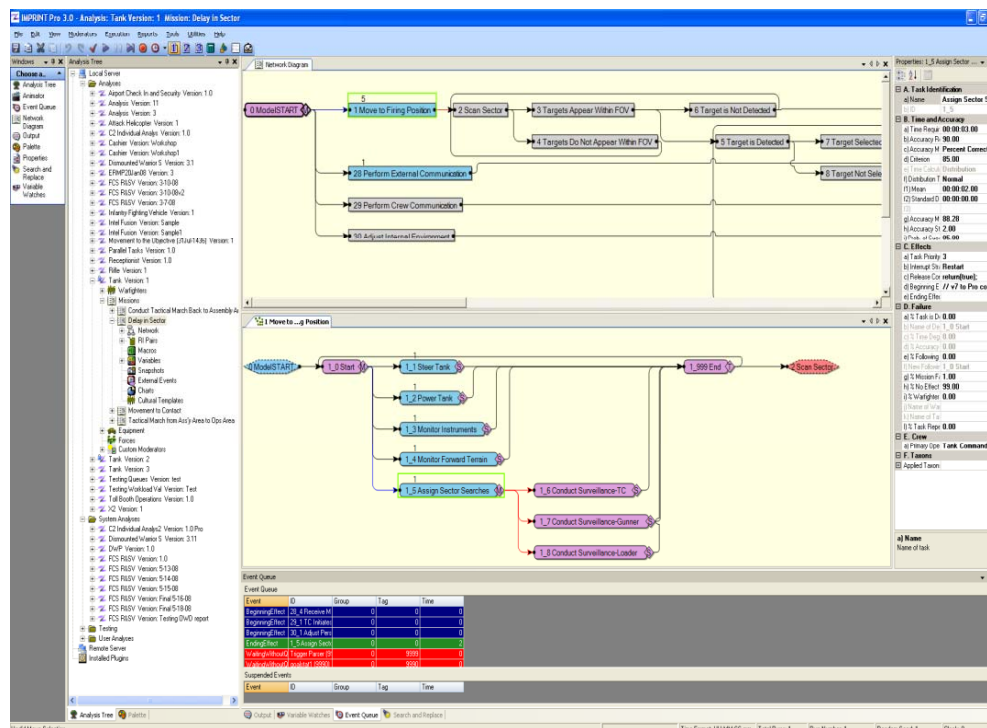


Improved Performance Research Integration Tool

stochastic discrete event simulation tool



*334 users supporting Army, Navy, Air Force,
Marines, NASA, Department of Homeland
Security (DHS), Department of Transportation
(DoT), Joint and other organizations
across the country*



<http://arl.army.mil/IMPRINT>

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- Set realistic system requirements
- Identify future manpower & personnel constraints
- Evaluate operator & crew workload
- Test alternate system-crew function allocations
- Assess required maintenance manhours
- Assess performance during extreme conditions
- Examine performance as a function of personnel characteristics and training frequency & recency
- Identify areas to focus test and evaluation resources
- Quantify human system integration risks in mission performance terms to support milestone review
- Represent humans in federated simulations

IMPRINT is a trade-off analysis tool



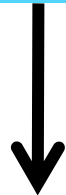
Socio-Cultural Modeling



*Identify socio-cultural factors that influence
Soldier/Commander decision making and communication*



*Build cognitive framework and models of socio-cultural
influence on Soldier/Commander decision making and
communication*



*Develop and validate guiding principles and concepts for
effective depiction and understanding of relevant socio-
cultural information*

**Power
distance**

**Uncertainty
avoidance**

Ethnic Identity

Social Status

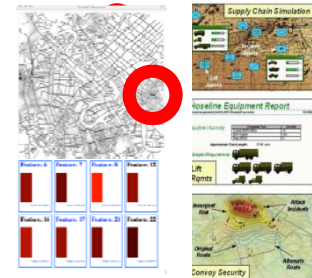


Socio-Cultural Modeling: The Next Two Years



In FY11, identify applicable data, models, algorithms and research gaps that capture socio-cultural influences on decision making and communication; conduct empirical research to fill existing gaps; develop a taxonomy of socio-cultural factors that influence decision making and communication

In FY12, develop cognitive framework and models depicting influence of socio-cultural factors on Soldier/Commander decision making and communication



Asymmetric Threat Tracker and sustainment planning tools



GlobeSmart®
Commander
and Soldier



CASMIRR

